Amendments to the Specification

Please replace the title as follows:

ELECTRIC-COMPONENT MOUNTING SYSTEM FOR MOUNTING ELECTRIC COMPONENT ON A CIRCUIT SUBSTRATE

Please replace paragraph **[0002]** with the following rewritten paragraph:

[0002] JP-A-6-342998 discloses an example of an electric-component mounting system including a plurality of component-holding heads which are arranged around a common axis of turning and turned about this common axis, to mount electric components on a printed-wiring board. The component-holding heads are disposed on an indexing body rotatable about a vertical axis, such that the component-holding heads are equiangularly spaced apart from each other along a circle having a center on the vertical axis of rotation of the indexing body. With a rotary intermittent motion of the indexing body, the component-holding heads are turned about the vertical axis of rotation of the indexing body (which is the above-indicated common axis of turning of the heads). The indexing body has a plurality of working positions or stations at which the component-holding heads are temporarily stopped. These working positions includes a component-receiving position and a component-mounting position. At the component-receiving position, the component-holding head receives an electric component from a component supply device. At the ~~component-holding~~ component-mounting position, the electric component is transferred from the component-holding head onto the printed-wiring board.

Please replace paragraph **[0004]** with the following rewritten paragraph:

[0004] The different component-holding heads have respective different positioning errors relative to the printed-wiring-board supporting and positioning device, and each component-holding head has substantially the same positioning error relative to the printed-wiring-board supporting and positioning device, for all of different kinds of electric

components and for all of different mounting positions on the board. In view of these facts, it is a conventional practice to obtain the amount and direction of positioning error of each of the plurality of component-holding heads, and board-positioning data to position the printed-wiring board upon mounting of the electric components on the board are compensated on the basis of the obtained amount and direction of the positioning error, so that the electric components are mounted at the respective nominal positions. Thus, the position of the board upon mounting of each electric component is adjusted to reduce or eliminate ~~he~~ the positioning error of each component with respect to the nominal mounting position.

Please replace paragraph **[0005]** with the following rewritten paragraph:

[0005] The present inventors attempted to increase the acceleration and deceleration of the component-holding heads during movements of the heads, in an effort to reduce the required time of the movements for thereby improving the efficiency of mounting of the electric components. However, the increased acceleration and deceleration of the component-holding heads resulted in a considerable amount of deviation of the actual mounting positions of the electric components with respect to the nominal mounting positions, in spite of the compensation of the board-positioning data on the basis of the obtained amount and direction of the positioning error of each component-holding head. It was found that the amount and direction of the positioning error of a ~~give~~ given component-holding head which is obtained during a movement of the head at a speed controlled in a certain pattern do not permit elimination or sufficient reduction of the positioning error of the same component-holding head when the head is moved at a speed controlled in another pattern. In this case, the mounting accuracy of the electric component is deteriorated. Thus, there is a limitation in the degree of improvement of the component mounting efficiency by reducing the required time of movement of the component-holding head, while assuring a sufficiently high degree of component mounting accuracy. This limitation appears to arise

from an increased amount of vibration of the component-holding head caused by the increased acceleration and deceleration of the head, due to insufficient rigidity of the component-holding head and a device including the indexing body for turning the component-holding head. Namely, the electric component appears to be mounted on the printed-wiring board before the vibration has been sufficiently attenuated after the head is stopped. Although it is considered to improve the component mounting accuracy by increasing the rigidity of the component-holding head and the turning device, an increase in the rigidity necessarily causes an increase in the masses of the head and the turning device, which in turn causes problems such as deterioration of the component mounting accuracy, and an increase in the cost of manufacture of the electric-component mounting system.

Please replace paragraph **[0014]** with the following rewritten paragraph:

[0014] In the electric-component mounting system according to the above mode (2), the component-holding device is moved by the XY robot to a predetermined component-mounting position on the printed-wiring board. In this case, the direction of the movement of the component-holding device to the component-mounting position and the pattern of control of the moving speed of the ~~component-mounting position~~ component-holding device change depending upon the component-mounting position and are not constant for all of the electric components. Accordingly, the control target used to position the component-holding device is required to be determined depending upon the component-mounting position. Thus, the principle of this invention is applicable to the present mounting system wherein the component-holding head is moved to each component-mounting position. However, the application of the principle to this type of system requires a relatively complicated control. Where the component-holding device uses a suction nozzle arranged to hold the electric component by suction under a negative pressure, for example, the acceleration and deceleration values of the suction nozzle during its movement to the component-mounting

position are desirably changed or controlled depending upon the mass and/or the height dimension of the electric component, in order to prevent dislocation of the electric component with respect to the suction nozzle, or falling of the electric component from the suction nozzle, which dislocation or falling may take place due to an inertia. In this case, the pattern of control of the moving speed of the component-holding device is changed or controlled by controlling the pattern of control of the operating speed of the XY robot. A change of the pattern of control of the moving speed of the component-holding device during its movement to a predetermined component-mounting position causes a change of the actual mounting position of the electric component, since the change of the pattern of control causes a change in the degree of elastic deformation of the component-holding device and a supporting device supporting the component-holding device, which occurs upon stopping of the component-holding device at the predetermined component-mounting position to mount the electric component. In view of this fact, one of the different control targets for establishing the predetermined relative position between the component-holding device and the board-supporting device is selected depending upon the specific pattern of control of the operating speed of the XY robot, that is, the specific pattern of control of the moving speed of the component-holding device, so that the positioning error of the electric component due to a varying degree of elastic deformation of the component-holding head and the supporting device can be reduced or prevented.

Please replace paragraph **[0044]** with the following rewritten paragraph:

[0044] The component supply device 14 includes a plurality of tape feeders 26 mounted on a feeder support table 24. In the present embodiment, each of the tape feeders 26 is arranged to feed a carrier tape (not shown) which accommodates electric components (typically, electronic components) 28, one of which is shown in Fig. 5. The carrier tape includes a carrier substrate which has a multiplicity of component-accommodating recesses

formed at a suitable interval along the length of the tape. The electric components 28 are accommodated in the respective component-accommodating recesses, and the opening of each recess is closed by a covering film bonded to the carrier substrate. The carrier tape is fed by a tape feeding device while the covering film is separated from the carrier substrate. Thus, the electric components ~~38~~ 28 are fed one after another to a predetermined position at a component-supply portion of the tape feeder 26. The plurality of tape feeders 26 are removably mounted on the feeder support table 24 such that the component-supply portions of the tape feeders 26 are arranged along a straight line, namely, along a horizontal straight line in the present embodiment. The direction of extension of this straight line is referred to as an X-axis direction (right and left direction) as indicated in Fig. 1.

Please replace paragraph **[0046]** with the following rewritten paragraph:

[0046] The printed-wiring-board supporting and positioning device 18 (hereinafter referred to as "PWB supporting and positioning device") includes a board-supporting device in the form of a printed-wiring-board supporting device (hereinafter referred to as "PWB supporting device") 40 arranged to support the printed-wiring board 38 on which the electric components ~~38~~ 28 are to be mounted, and a board-positioning device in the form of a printed-wiring-board positioning device (hereinafter referred to as "PWB positioning device") 44 arranged to move the PWB supporting device 40, for thereby positioning the printed-wiring board 38. The PWB positioning device 44 includes an X-axis slide 54, and a Y-axis slide 62 movably mounted on the X-axis slide 54. The X-axis slide 54 is movable in the X-axis direction by an X-axis drive motor 48 through a feedscrew in the form of a ballscrew 50 while being guided by guide rails 52, while the Y-axis slide ~~52~~ 62 is movable in a Y-axis direction (perpendicular to the X-axis direction) by a Y-axis drive motor 56 through a feedscrew in the form of a ballscrew 58 while being guided by a guide rail 60. The PWB supporting device 40 rests on the Y-axis slide 62, on which is placed the printed-wiring board

38 such that the board 38 maintains a horizontal attitude or posture in which an upper surface or component-mounting surface 64 (Fig. 2) of the board 38 is parallel to an XY plane defined by the mutually perpendicular X-axis and Y-axis directions. The PWB supporting device 40 is moved the PWB positioning device 44 in the XY plane (horizontal plane parallel to the component-mounting surface 64), so that a selected portion of the surface 64 is located at a predetermined component-mounting position described below.

Please replace paragraph **[0047]** with the following rewritten paragraph:

[0047] The printed-wiring board 38 is provided on its component-mounting surface ~~38~~ 64 with a plurality of fiducial marks (not shown), two fiducial marks in this embodiment. The present electric-component mounting system 12 is provided with an image-taking device in the form of a stationary fiducial-mark camera 70, as shown in Fig. 1. The fiducial-mark camera 70 is arranged to take images of the fiducial marks on the printed-wiring board 38 as held by the PWB supporting device 40. The fiducial-mark camera 70 includes CCDs (charge-coupled devices) and a lens system. The CCDs are small-sized light-sensitive elements arranged in a matrix in a plane. Each of the light-sensitive elements generates an electric signal depending upon amount of light received. The matrix of the light-sensitive elements defines an imaging area in which a two-dimensional image of an object is formed at one time. An illuminating device (not shown) is provided near the fiducial-mark camera 70, to illuminate the object and its vicinity when the image of the object is taken by the camera 70.

Please replace paragraph **[0054]** with the following rewritten paragraph:

[0054] The cam groove 148 is formed in the outer circumferential surface of the large-diameter portion 146 of the cylindrical cam 144, such that the height of the cam groove 148 gradually changes in the circumferential direction of the cylindrical cam 144, over selected two portions of the circumference of the cylindrical cam 144. When the component-

holding heads 140 are turned with the vertically movable plates 150 about the axis of the indexing body 126, with an intermittent rotary motion of the indexing body 126, the pairs of rollers 152 are moved in the helical cam groove 148, so that the vertically movable plates 150 are vertically moved to vertically move the corresponding component-holding heads 140. The cam groove 148 is formed such that the component-holding head 140 located at the component-receiving position (component-holding or component-sucking position) is located at the uppermost position, while the component-holding head 140 located at the component-mounting position is located at the lowermost position. That is, each component-holding head 140 receives the electric component 28 from the appropriate tape feeder 26 when this head 140 is located at the component-receiving position and at the uppermost position. The component-holding head 140 is lowered to the lowermost position while this head 140 is turned to the ~~component-holding~~ component-mounting position at which the electric component 28 is mounted on the printed-wiring board 38. The height of the cam groove 148 remains unchanged over two other portions of the circumference of the cylindrical cam 144 other than the above-indicated selected two portions, so that each component-holding head 140 is turned without a vertical movement, along the above-indicated two other portions of the circumference of the cam 144, which are comparatively remote from the component-receiving and component-mounting positions in the rotating direction of the indexing body 126.

Please replace paragraph **[0055]** with the following rewritten paragraph:

[0055] A vertically movable member in the form of a rod 170 is supported by a support member 164 attached to the outer surface of each of the vertically movable plates ~~140,~~ 150, as shown in Fig. 4, such that the vertically movable rod 170 is not axially movable relative to the support member 164 and is rotatable about its vertically extending axis. The vertically movable rod 170 is connected to a rotation transmitting shaft 172 to which a rotary

motion is transmitted from each of: an angular-component-position 90°-changing device disposed at the angular-component-position 90°-changing position; a component hold-position rectifying device disposed at the component-hold-position rectifying position; an angular-head-position resetting device disposed at the angular-head-position resetting position; and an angular-head-position 90°-reversing device disposed at the angular-head-position 90°-reversing position. The component-holding head 140 is rotated about its axis by the vertically movable rod 170 when the rotary motion is transmitted from each of the above-indicated devices to the rod 170 through the rotation transmitting shaft 172. As shown in Figs. 4 and 5, the rotation transmitting shaft 172 includes: a spline shaft 176 connected to the vertically movable rod 170 through a universal joint 174; a sleeve 178 fitted on the spline shaft 176 such that the sleeve 178 is axially movable relative to the spline shaft 176 but is not rotatable relative to the spline shaft 176; and an engaging member 182 connected to the sleeve 178 through a universal joint 180. The rotation transmitting shaft 172 is telescopically elongated and contracted through a relative axial movement of the spline shaft 176 and the sleeve 178.

Please replace paragraph **[0059]** with the following rewritten paragraph:

[0059] As shown in Fig. 6, each suction nozzle 210 has a nozzle body 216, a suction tube ~~218and~~ 218 and a light-emitting body in the form of a light-emitting plate 220 serving as a light emitting member. The light-emitting plate 220 absorbs a ultraviolet radiation received from a ultraviolet-radiation emitting device disposed at the component-hold-position detecting position, and emits a visible light. The suction tube 218 and the light-emitting plate 220 of each suction nozzle 210 have sizes suitable for the particular kind or type of the electric component 28 (Fig. 5). The six suction nozzles 210 are used to hold the electric components 28 having respective different sizes (different height dimensions and/or masses),

and the suction tubes 218 of the six suction nozzles 210 have respective different diameters. In the present embodiment, all of the six suction nozzles 210 are different from each other in the diameter of the suction tubes 218. It is noted that the suction tubes 218 have the same length.

Please replace paragraph **[0061]** with the following rewritten paragraph:

[0061] The rotary drive rod 226 is selectively connected to and disconnected from the nozzle holder 202 through a switching device 228, which is driven by the intermittent rotary drive motor 114. The switching device 228 includes a lifting and lowering rod 238 which is connected to the rotary drive motor 114 through a motion-converting mechanism which includes a cam, a cam follower, and a motion-transmitting mechanism supporting the cam follower. The motion-converting mechanism is arranged to convert a rotary motion of the rotary drive motor 114 into a linear motion of the lifting and lowering rod 238. Since the rotary drive motor ~~113~~ 114 is kept operated, the lifting and lowering rod 238 is lowered only when the nozzle holder 202 is rotated to select one of the six suction nozzles 210. The motion-converting mechanism is constructed as in an electronic-component mounting system disclosed in JP-B2-3050638. The lifting and lowering rod 238 is connected to the rotary drive rod 226 through a ~~lever,~~ lever 240, a connecting rod 242 and a lever 244. When the rod 238 is vertically moved, the lever 240 is pivoted to vertically ~~moved~~ move the connecting rod 242, so that the lever 244 is pivoted to move the rotary drive rod 226 between an operated position in which the engaging teeth 236 engage the engaging grooves 234 of the nozzle holder 202, and a non-operated position in which the engaging teeth 236 are released from the engaging grooves 234.

Please replace paragraph **[0065]** with the following rewritten paragraph:

[0065] As shown in Fig. 5, the lifting and lowering rod 170 is provided with a switch valve 256 arranged to selectively communicate the suction nozzle 210 with the negative-

pressure source or the atmosphere. The switch valve 256 includes a switching sleeve 258 axially movably fitted on the lifting and lowering rod 170. The switching sleeve 258 is axially movable by a switching device 260, between its uppermost position as an atmospheric-pressure position in which the suction tube 218 of the suction nozzle 210 placed in the operating position is communicated with the atmosphere, and its lowermost position as a negative-pressure position in which the suction tube 218 is communicated with the negative-pressure source. The switching device 260 includes a pusher pin 262 attached to the support member 164, a pusher lever 264 provided at the component-receiving position, and a bar (not shown) provided at the component-mounting position. The switching sleeve 258 of the switch valve 256 is mechanically moved in its axial direction by the switching device 260, relative to the lifting and lowering rod 170, when the component-holding head 140 is vertically moved as a result of its turning movement about the axis of the indexing body 126 between the component-receiving position and the component-mounting position. Described more specifically, the switching sleeve 258 is placed in its negative-pressure position when the component-holding head 140 is placed in the component-receiving position, so that the suction tube 218 is communicated with the negative-pressure source, for holding the electric component 28 by suction under the negative pressure. When the component-holding head 140 has been moved to the ~~component-holding~~ <u>component-mounting</u> position, the switching sleeve 258 is moved to its atmospheric-pressure position for communicating the suction tube 218 with the atmosphere, for releasing the electric component 28. The switching sleeve 258 is held in its negative-pressure position while the component-holding head 140 is moved from the component-receiving position to the component-mounting position, so that the electric component 28 is kept held by the suction tube 218 until the electric component 28 has reached the component-mounting position.

Please replace paragraph **[0066]** with the following rewritten paragraph:

[0066] As indicated above, the angular-component-position 90°-changing device, component hold-position rectifying ~~device disposed,~~ device, angular-head-position resetting device and angular-head-position 90°-reversing device are disposed at the angular-component-position 90°-changing position, component hold-position rectifying position, angular-head-position resetting position and angular-head-position 90°-reversing position, respectively. Each of these devices includes: an engaging member engageable with and disengageable from the rotation transmitting shaft 172 of each component-holding head 140; a connecting device for selective engagement with or disengagement from the rotation transmitting shaft 172; and a rotating device for rotating the engaging member. The connecting device uses the intermittent rotary drive motor 114 as a drive source, a rotary motion of which is converted into a linear vertical motion of the engaging member by a motion-transmitting or motion-converting device including a cam and a cam follower.

Please replace paragraph **[0073]** with the following rewritten paragraph:

[0073] To the input-output interface 312, there are also connected the fiducial-mark camera 70 and the component camera 296 through respective control circuits 318. The RAM 306 stores various control programs and data such as component-mounting control programs for mounting the electric components ~~38~~ 28 on the printed-wiring boards 38, positioning-error detecting control programs for obtaining the amounts and directions of positioning errors of the electric components 28 with respect to the nominal component-mounting positions on the printed-wiring boards 38, depending upon different patterns of control of the speed of turning movement of the component-holding heads 140.

Please replace paragraph **[0074]** with the following rewritten paragraph:

[0074] There will next be described an operation of the present electric-component mounting system constructed as described above. The 16 component-holding heads ~~14~~ 140 are intermittently turned with an intermittent rotary movement of the indexing body 126, and temporarily stopped at the 16 working positions, so that the electric component 28 is held by the component-holding head 140 located at the component-receiving position, and is mounted on the printed-wiring board 38 when the same component-holding head 140 is moved to the component-mounting position. Further, the position of the printed-wiring board 38 at which an operation to mount each electric component 28 is performed is adjusted or compensated, depending upon the pattern of control of the speed of turning movement of the component-holding head 140 and the kind of the suction nozzle 210 used for mounting the electric component 28 on the board 38. Initially, there will be described a basic operation to mount the electric component 28 on the printed-wiring board 38. Then, there will be described operations to obtain and correct the positioning errors of the electric component 28 with respect to the nominal mounting position, depending upon the pattern of control of the turning movement of the component-holding head 140 and the kind of the electric component ~~28~~ 28.

Please replace paragraph **[0075]** with the following rewritten paragraph:

[0075] Different kinds of positioning errors of the electric component ~~38~~ 28 held by each of the 16 component-holding heads 140 are detected at the three working positions, and the component-holding heads 140 located at the respective eight working positions perform respective different operations concurrently with each other. The operations performed by each component-holding head 140, which will be described only briefly, are identical with those as disclosed in JP-A-6-342998.

Please replace paragraph **[0077]** with the following rewritten paragraph:

[0077] As described below, the component-holding head 140 is not turned in a predetermined constant pattern of control of the turning speed, but is turned in a selected one of different patterns of control of the turning speed, more precisely, in a selected one of different combinations of a time duration for which the head 140 is turned, and a time duration for which the head 140 is stopped at each working position. The pattern of control <u>of</u> the turning speed of the component-holding head 140 can be changed by changing the rotating speed of the cam 112. The relative movement between the engaging member 182 and the component-holding head 140 illustrated in Fig. 8 is the one when the cam 112 is rotated at a speed which is 80% of the maximum rotating speed, while the head 140 is turned between the adjacent working positions and is held stopped at each working position. The angle indicated in the time chart of Fig. 8 is the angle of rotation of the cam 112 to rotate the indexing body 126. One full rotation of the cam 112 causes each component-holding head 140 to be moved from one working position to the next adjacent working position and held at this latter working position.

Please replace paragraph **[0078]** with the following rewritten paragraph:

[0078] When the cam 112 has been rotated by 60° to rotate the indexing body 126, the rotation of the externally toothed ring gear 186 is initiated. The component-holding head 140 is moved in an initial portion of the rotation of the indexing body 126, during which the externally toothed ring gear 186 of the rotation transmitting shaft ~~162~~ <u>172</u> is held stopped. The ring gear 186 is rotated until the cam 112 has been rotated by 180°, that is, for a time duration of 30ms. Since the angular velocity of the ring gear 186 is two times that of the indexing body 126, the engaging member 182 is moved from one working position to the adjacent working position in 30ms while the component-holding head 140 is moved between those two working positions in 60ms. Accordingly, the engaging member 182 whose

movement has been initiated after the movement of the head 140 leads the head 140 during the movements of the engaging member 182 and head 140, and reaches the adjacent working position before the head 140 while the head 140 is still being moved with the indexing body 126.

Please replace paragraph **[0085]** with the following rewritten paragraph:

[0085] The component-holding head 140 is then moved to the component hold-position rectifying position at which the head 140 is rotated by a suitable angle by the component hold-position rectifying device, so as to eliminate the obtained angular positioning error $\Delta\theta$, and board-positioning data to position the printed-wiring board 38 for mounting the electric component 28 thereon are adjusted to compensate for the horizontal positioning errors ΔXE and ΔYE of the electric component 28 as held by the suction nozzle 210. The adjustment of the board-positioning data is also made at this time to compensate for a horizontal relative positioning error between the printed-wiring board 38 and the PWB supporting device 40. To this end, the positioning error of the board 38 positioned on the PWB supporting device 40 in the horizontal plane is calculated on the basis of images of the fiducial marks taken by the fiducial-mark camera 70. On the basis of the calculated horizontal positioning error of the board 38, horizontal positioning errors ΔXP and ΔYP of each component-mounting spot or position on the board 38 are calculated. X-axis movement data and Y-axis movement data of the board-positioning data used to position the printed-wiring board 38 in the XY plane are adjusted to compensate for the thus obtained horizontal positioning errors ΔXP and ΔYP of each component-mounting spot on the board 38, the horizontal positioning errors ΔXE and ΔYE of the electric component 28 as held by the suction nozzle 210, and changes of the center position of the electric component 28 in the X-axis and Y-axis direction, which changes take place due to the compensation of the angular

positioning error Δθ of the electric component 28. Then, the component-holding head 140 is moved to the ~~component-holding~~ component-mounting position at which the electric component ~~38~~ 28is transferred from the component-holding head 140 onto the corresponding mounting spot on the printed-wiring board 38.

Please replace paragraph **[0089]** with the following rewritten paragraph:

[0089] Then, the component-holding head 140 is moved to the component disposing position to discard the electric component ~~38~~ 28 abnormally held by the suction nozzle 210, for example, the electric component ~~38~~ 28 which was detected, at the component-upright-attitude detecting position, to have an upright attitude, or the electric component ~~38~~ 28 which was detected, at the component hold-position detecting position, to have positioning errors that are too large to be eliminated at the component hold-position rectifying position.

Please replace paragraph **[0092]** with the following rewritten paragraph:

[0092] The 16 component-holding heads 140 are intermittently turned with the intermittent rotary motion of the indexing body 126, to successively hold the electric components 28 received from the tape feeder 26, and mount the electric components 28 onto the printed-wiring board 38, while the cam 112 is kept rotated by the intermittent rotary drive motor 114. By controlling the operating speed of the rotary drive motor 114 to control the rotating speed of the cam 112, it is possible to change the pattern of control of the operating speed of the head turning device 142, more specifically, to control the acceleration and deceleration values and the maximal value of the turning speed of each component-holding head 140, and to control the time required for moving the head 140 between the adjacent working positions and the length of time (stopping time) for which the head 140 is held stopped at each working position. The acceleration and deceleration values, maximal turning speed and stopping time of the head 140 are determined by the configuration and operating speed of the cam 112. As the rotating speed of the cam 112 is increased, the acceleration and

deceleration values and maximal speed of the head 140 are increased, while the required time (required movement time) for moving the head 140 between the adjacent working positions and the stopping time are reduced. Where the rotating speed of the cam 112 is held constant throughout the full rotation of the cam 112, the required movement time is reduced with an increase in the acceleration and deceleration values and maximum speed of the head 140, and the stopping time is reduced as the required movement time is reduced. However, the required movement time and the stopping time can be controlled as desired independently of each other, by controlling the rotating speed of the cam 112 such that the rotating speed during the turning movement of the head 140 is different from that during stopping of the head 140 at each working position. In view of this fact, the present embodiment is arranged to control the pattern of control of the turning speed of each component-holding head 140, by suitably controlling both of the moving and stopping times of the head 140, that is, by controlling both of the rotating speeds of the cam ~~114~~ 112 during the turning movement and the stopping of the head ~~14.~~ 140.

Please replace paragraph **[0093]** with the following rewritten paragraph:

[0093] The moving time of the head 140 is determined by various factors such as the size of the electric component 28 to be mounted on the board 38. Where the electric component 28 has a relatively large height dimension and/or a relatively large mass, the electric component 28 may be dislocated with respect to the suction nozzle 210 or may fall from the suction nozzle 210 when the head ~~14~~ 140 is moved at a relatively high speed. In this case, it is required to reduce the acceleration and deceleration values of the head 140 and increase the moving time of the head 140. Where the electric components ~~38~~ 28 already mounted on the printed-wiring board ~~28~~ 38 have a relatively large height dimension and/or a relatively large mass, the electric components 28 may be dislocated with respect to the board ~~28~~ 38 or turned on the board 38 when the board 38 is moved at high acceleration and

deceleration values. In this case, it is required to reduce the acceleration and deceleration values of the board 38 and increase the moving time of the board 38. Since the turning movement of the head 140 to the component-mounting position is synchronized with the positioning of the board 38, the moving time of the head 140 may be required to be increased to increase the moving time of the board 38. In this respect, it is noted that the required distance of movement of the board 38 is usually small, the movement of the board 38 is usually effected at relatively low acceleration and deceleration values. Generally, the electric components 28 which have comparatively small sizes and/or masses and which are comparatively less ~~like~~ likely to be dislocated with respect to the board 38 or turned on the board 38 are mounted on the board 38 before the electric components ~~38~~ 28 having comparatively large sizes and/or masses. Accordingly, the acceleration and deceleration values of the head 140 are reduced and the moving time of the head 140 is increased as the size of the electric component 28 to be mounted on the board 38 is increased, that is, as the acceleration and deceleration values of the board 38 are reduced to increase the moving time of the board 38. Therefore, the moving time of the head 140 is not usually determined by the moving time of the board 38, but is determined by the size and mass of the electric component 28 held by the head 140. Where the distance of movement of the board 38 is comparatively large and the required moving time of the board 38 is relatively long, it may be required to increase the moving time of the head 140 for synchronization of the movement of the head 140 to the component-mounting position with the movement of the board 38.

Please replace paragraph **[0094]** with the following rewritten paragraph:

[0094] The required stopping time of the head 140 is determined by the angle of rotation of the nozzle holder 202 to bring the next selected suction nozzle 210 into its operating position. As described above, each of the 16 component-mounting units 237 has a total of six suction nozzles ~~320~~ 210 which are selectively placed in the operating position for

holding the electric components 28 of the respective different kinds. To bring a selected one of the six suction nozzles 210 into its operating position, the nozzle holder 202 is rotated clockwise or counterclockwise by 60°, 120° or 180°, that is, by a maximum angle of 180°. The required stopping time of the component-holding head 140 increases with an increase in the required angle of rotation of the nozzle holder 202 to bring the selected suction nozzle 210 into its operating position.

Please replace paragraph **[0095]** with the following rewritten paragraph:

[0095] The moving time and stopping time of the component-holding head 140 may be controlled in various manners. For instance, the rotating speed of the cam 112 is changed in three steps, namely, controlled to be one of 100%, 80% and 60% of the maximum speed, depending upon the kind of the electric component 28. For example, where the size of the electric component 28 is small enough to permit the head 140 to be moved at comparatively high acceleration and deceleration values without a risk of falling or dislocation of the electric component 28 from or with respect to the head ~~150,~~ 140, the rotating speed of the cam 112 during the turning movement of the head 140 is controlled to the maximum value. Where the size of the electric component 28 is too large to permit the head 140 to be moved at comparatively high acceleration and deceleration values, the rotating speed of the cam 112 during the turning movement of the head 140 is controlled to be 80% or 60% of the maximum value.

Please replace paragraph **[0096]** with the following rewritten paragraph:

[0096] Where the nozzle holder 202 is required to be rotated by 180° to bring the selected suction nozzle 210 into its operating position, the rotating speed of the cam 112 during stopping of the component-holding head 140 may be controlled to be 60% of the maximum value. Where the nozzle holder 202 is required to be rotated by 120° or 60° to

bring the selected suction nozzle 210 into its operating operation, the rotating speed of the cam 112 may be controlled to be 80% of the maximum value. Where the nozzle holder 202 is not rotated, that is, where the suction nozzle 210 used to hold the electric component 28 is not changed, the cam 112 is rotated at its maximum speed during stopping of the head ~~180.~~ 140. The rotating speed of the cam 112 during stopping of the head ~~180~~ 140 may be controlled to be the maximum value where the nozzle holder 202 is rotated by 60°, and to be 60% of the maximum speed where the nozzle holder 202 is rotated by 120°. The cam 112 may be rotated at its maximum speed while the component-head 140 is stopped at the component hold-position rectifying position at which the head 140 is rotated for compensation of the angular positioning error $\Delta\theta$ of the electric component 28.

Please replace paragraph **[0099]** with the following rewritten paragraph:

[0099] The rotating speed of the cam 112 during movement of each component-holding head 140 is stored in the RAM 306 of the computer 310, in relation to the kind of the electric component 28 to be mounted on the printed-wiring board 38. When the electric component 28 is mounted on the printed-wiring board 38 according to the component-mounting programs, the rotating speed of the cam 112 corresponding to the specific kind of the electric component ~~38~~ 28 is read out from the RAM 306, to rotate the cam 112 at this rotating speed. Further, the rotating speed of the cam 112 is stored in the RAM 306, in relation to the required angle of rotation of the nozzle holder 202 to select each of the suction nozzles 210. When the desired suction nozzle 210 is brought into its operating position, the rotating speed of the cam 112 corresponding to the required angle of ~~ration~~ rotation of the nozzle holder 202 to bring this suction nozzle 210 into its operating position is read out from the RAM 306, to rotate the cam 112 at this rotating speed.

Please replace paragraph **[0102]** with the following rewritten paragraph:

[0102] To eliminate this positioning error of the electric component 28 or suction nozzle 210, the position to which the printed-wiring board 38 is moved by the PWB positioning device 44 is adjusted. Normally or theoretically, the printed-wiring board 38 is moved to a position at which the nominal mounting position of the electric component 28 is right below the suction nozzle 210, and the board 38 is moved to this position by the PWB positioning device 44 when each electric component 28 is mounted ~~n~~ on the board 38. In this case, there arises a relative positioning error between the suction nozzle 210 (component 28) and each component-mounting position on the board 38, for the reason described above. If the position to which the board 38 is moved is adjusted to prevent the positioning error when the cam 112 is rotated at 80% of the maximum speed, there arises the positioning error when the cam 112 is rotated at the maximum speed, and moreover, the amount of the positioning error of the component 28 is increased, as indicated in Fig. 10. Similarly, the amount of the positioning error when the cam 112 is rotated at 80% of the maximum speed is increased where the position to which the board 38 is moved is adjusted to prevent the positioning error when the cam 112 is rotated at the maximum speed. In the present embodiment, the amount and direction of the positioning error of the electric component 28 to be mounted on the board 38 are obtained at the different rotating speeds of the cam 112, before the component 28 is mounted on the board 38.

Please replace paragraph **[0103]** with the following rewritten paragraph:

[0103] The suction nozzles 210 placed in the operating position on the respective nozzle holders 202 of all of the component-holding heads 140 are located at the same position when the corresponding heads 140 reach the component-mounting position with an intermittent rotary motion of the indexing body 126, so that the operations to mount the electric components 28 on the board 38 are performed with the suction nozzles 210 located at

the same position. Accordingly, the amount and direction of the positioning error of the electric components 28 mounted on the board ~~28~~ 38 are the same for all of the suction nozzles 210 (all of the heads 140), provided that the suction nozzles 210 are of the same kind and that the cam 112 is rotated at the same speed, irrespective of the specific kind and mounting position of the electric components 28. In view of this, the amount and direction of the positioning error of the electric component 28 are obtained for each of the different kinds of the suction nozzles 210, at different rotating speeds of the cam 112.

Please replace paragraph **[0105]** with the following rewritten paragraph:

[0105] In the present embodiment, the amount and direction of the positioning error are detected by using test chips 330 and a test substrate 332, as schematically illustrated in Fig. 11. The test chips 330 are supplied from an exclusive test-chip feeder 334 disposed on the feeder support table 24, as shown in Fig. 1. Like the tape feeders 26 for the electric components 28, the test-chip feeder 334 includes a test-chip feeding device adapted to feed a carrier tape accommodating a multiplicity of test chips 330 so that the test chips 330 are successively supplied one after another to a chip-supply portion. Like the carrier tape accommodating the electric components ~~38,~~ 28, the carrier tape accommodating the test chips 330 includes a carrier substrate which has a multiplicity of chip-accommodating recesses for accommodating the respective the test chips. The recesses are closed by a covering film to prevent removal of the test chips 330 during the feeding of the carrier tape. The test-chip feeder 334 is removably mounted on the feeder support table 24, for instance, at one end of the feeder support table 24, such that the chip-supply portion of the test-chip feeder 334 lies on the straight line along which the component-supply portions of the tape feeders 26 are arranged. When the positioning error is detected, the feeder ~~supportable~~ support table 24 is moved to position the test-chip feeder 334 such that the chip-supply portion is located at the component-supply position at which the test chips 330 are picked up by the component-

holding heads 140, in the same manner as the electric components 28 supplied from the tape feeders 26.

Please replace paragraph **[0108]** with the following rewritten paragraph:

[0108] After the test chips 330 have been mounted on the test substrate 332, by all of the 16 component-holding heads ~~14,~~ 140, at the 100% and 80% values of the maximum speed of the cam 112, the next suction nozzle 210 is brought into its operating position on each of the 16 heads 140, and the test chips 330 are mounted with the cam 112 rotated at the 100% and 80% values of the maximum speed. That is, the nozzle holder 202 of the head 140 from which the test chip 330 has been transferred onto the test substrate 332 is rotated to bring the next suction nozzle 210 into the operating position, when the head 140 reaches the suction-nozzle selecting position.

Please replace paragraph **[0109]** with the following rewritten paragraph:

[0109] The operation to mount the test chips 330 on the test substrate 332 using the first suction nozzle 210 and at the 80% rotating speed of the cam 112 is terminated for all of the 16 component-holding head 140, before the suction nozzles 210 of all the heads 140 have been changed to the second suction nozzles 210. That is, when the test chip 330 is transferred to the test substrate 332 from the first suction nozzle 210 of the last or sixteenth head 140 which is moved with the cam 112 rotated at the 80% speed, the first suction nozzles 210 of the five heads 140 stopped at the working stations between the suction-nozzle selecting position and the component-mounting position remain in their operating position, that is, have not yet been changed to the second suction nozzles 210. To change these first suction nozzles 210 to the second suction nozzles 210, the nozzle holders 202 are required to be rotated by 60°. Therefore, this operation to change the first suction nozzles 210 to the second suction nozzles 210 is required to be performed while the cam 112 is rotated at the 80% speed. Accordingly, the heads 140 are turned with the cam 112 rotated at the 80% speed until

the first suction nozzles 210 of the above-indicated five heads ~~150~~ 140 are changed to the second suction nozzles 210 at the suction-nozzle selecting position. During this turning movement of the heads 140, the test chips 330 are picked up by the heads 140 reaching the component-receiving position, but the test chips 330 are not transferred to the test substrate ~~320~~ 332 from the second suction nozzles 210 of the heads at the component-mounting position, since the mounting of the test chips 330 from the second suction nozzles 210 must be performed initially with the cam 112 rotated at the 100% speed. After the second suction nozzles 210 are placed in the operating position on all of the heads 140, the cam 112 is rotated at the 100% speed, and the mounting of the test chips 330 onto the test substrate 332 is initiated. Hence, the head 140 at which the operation to transfer the test chips 330 from the second suction nozzles 210 onto the test substrate 332 is initiated is different from the head at which the operation to transfer the test chips 330 from the first suction nozzles 210 onto the test substrate 332 is initiated. This is true for the second and third suction nozzles 210, and the other adjacent suction nozzles 210.

Please replace paragraph **[0110]** with the following rewritten paragraph:

[0110] However, where the time required to rotate the nozzle holder 202 by ~~60~~ 60° is short enough to permit the nozzle holder 202 to be rotated to bring the next suction nozzle 210 into the operating state even at the 100% rotating speed of the cam 112, the mounting of the test chips 330 onto the test substrate 332 may be performed concurrently with the operation to change the suction nozzles 210, while the cam 112 is rotated at the 100% speed. Alternatively, the indexing body 126 may be rotated one full turn for the sole purpose of changing the suction nozzles 210 of all the heads 140 to the next suction nozzles 210. In this case, the operation to mount the test chips 330 is performed during the next one full rotation of the indexing body 126.

Please replace paragraph **[0111]** with the following rewritten paragraph:

[0111] Thus, the test chips 330 are mounted on the test substrate 332 using all of the ~~fix~~ six suction nozzles 210 and at the two different rotating speeds (100% and 80% of the maximum speed) of the cam 112. This series of operation is repeated a suitable number (N) of times, for example, three times. In this case, a total of six test chips 330 are mounted on the test substrate 332, for each suction nozzle 210, namely, three test chips 330 for each of the two different rotating speeds of the cam 112. The operation to mount the test chips 330 onto the test substrate 332, the operation to change the suction nozzles 210, the operation to control the rotating speed of the cam 112, and the operation to position the test substrate 332 to align the predetermined chip-mounting positions with the component-mounting position in the electric-component mounting system, are performed according to chip-mounting programs and substrate-positioning data (movement data for the test substrate 332) which are stored in the RAM 306. The substrate-positioning data are data used to control the PWB positioning device 44 for moving the PWB supporting device 40 to position the test substrate 332 such that the chip-mounting positions on the test substrate 332 are sequentially brought to the component-mounting position in the electric-component mounting system. In the present embodiment, the substrate-positioning data represent X-axis and Y-axis coordinate values with respect to an absolute zero point in the XY coordinate system, that is, in the horizontal XY plane. Thus, the substrate-positioning data are similar to the board-positioning data for positioning the PWB supporting device 40 to position the printed-wiring board 38 when the electric components 28 are mounted on the board 38. In the present embodiment, the absolute zero point is located such that the X-axis and Y-axis coordinate values of the substrate-positioning data and the board-positioning data are positive values.

Please replace paragraph **[0113]** with the following rewritten paragraph:

[0113] After all of the test chips 330 have been imaged, image data representative of the images of the test chips 330 are processed to obtain the amount and direction of a positioning error of each test chip 330. If the test ~~substrate~~ chip 330 is mounted at the nominal chip-mounting position without a positioning error, the image of this test chip 330 is formed at a predetermined position (e.g., at the center) of an imaging area of the fiducial-mark camera 70, as indicated by two-dot chain line in Fig. 12. If the test chip 330 is dislocated with respect to the nominal chip-mounting position, the image of the test chip 330 is offset from the predetermined position, as indicated in solid line in Fig. 12. In this figure, reference numeral 330 denotes the image of the test chip 330.

Please replace paragraph **[0117]** with the following rewritten paragraph:

[0117] The estimated positioning errors ΔXC and ΔYC were obtained by rotating the cam 112 at the same speed during the turning movement and stopping of the head 140. The actual positioning errors of the electric component 28 when the rotating speed of the cam 112 is held constant during the turning movement and stopping of the head 140 is considered to be the same as the estimated positioning errors ΔXC and ΔYC which were obtained at the same rotating speed of the cam 112. In this respect, it is reasonable to use the positioning errors ΔXC and ΔYC obtained at the rotating speed of the cam 112 which is the same as in the actual component-mounting operation. More specifically described, it is reasonable to use the positioning errors ΔXC and ΔYC obtained at the 80% speed of the cam 112, where the actual component-mounting operation is performed at the 80% speed during both of the turning movement and stopping of the component-holding head 140, and use the positioning errors ΔXC and ΔYC obtained at the ~~10%~~ 100% speed of the cam 112, where the actual

component-mounting operation is performed at the 100% speed during both of the turning movement and stopping of the head 140.

Please replace paragraph **[0119]** with the following rewritten paragraph:

[0119] Where the cam 112 is rotated at a low ~~high~~ speed during the turning movement of the head 140 and at a relatively high speed during the stopping of the head 140, a relatively small magnitude of vibration is generated upon stopping of the head 140 at each working position, and the vibration does not significantly influence the actual positioning error of the electric component 28, in spite of the relatively short stopping time of the head 140. Therefore, it is considered appropriate to use the estimated positioning errors ΔXC and ΔYC obtained when the cam 112 was rotated at the 80% speed.

Please replace paragraph **[0122]** with the following rewritten paragraph:

[0122] The estimated positioning errors ΔXC and ΔYC include the positioning error of the fiducial-mark camera 70 and the positioning error of the printed-wiring board 38 as positioned by the PWB positioning device 44. Namely, like the horizontal positioning errors ΔXP and ΔYP of each component-mounting position (suction nozzle 210), the positioning errors ΔXC and ΔYC are obtained on an assumption that the printed-wiring board 38 and the fiducial-mark camera 70 do not have a relative positioning error. That is, the horizontal positioning errors ΔXP and ΔYP are obtained on the basis of the image of the fiducial mark on the board 38, which is taken by the fiducial-mark camera 70, on an assumption that the camera 70 and the board 38 do not have a relative positioning error. Similarly, the positioning errors ΔXC and ΔYC are obtained on the basis of the images of the test chips 330 which are taken by the fiducial-mark camera 70 by moving the test substrate 332 to bring each component-mounting position to the imaging position of the camera 70, on an assumption that the camera 70 and the test substrate 332 do not have a relative positioning

error. For improved mounting accuracy of the electric components 28 on the printed-wiring board 38, the board-positioning data are compensated for not only the obtained horizontal relative positioning errors ΔXP, ΔYP between the board 38 and the PWB supporting device 40 and the estimated relative positioning errors ΔXC, ΔYC between the suction nozzle ~~110~~ 210 and each component-mounting position on the board 38, but also the relative positioning error between the fiducial-mark camera 70 and the board 38 and the positioning error of the board 38 as positioned by the PWB positioning device 44.

Please replace paragraph **[0127]** with the following rewritten paragraph:

[0127] The control device 300 includes a positioning portion, and a control-target determining portion which includes speed-control-pattern changing means, test-chip mounting control means, data processing means, and control-target determining means. It will be understood from the foregoing description of the present embodiment that the positioning portion is a portion of the control device 300 assigned to obtain the amount and direction of the positioning error of each suction nozzle 210 used to adjust the board-positioning data for positioning the PWB supporting device 40 to thereby position the printed-wiring board 38, and adjusting the board-positioning data on the basis of the obtained amount and direction of the positioning error of the suction nozzle 210. The positioning portion is arranged to obtain the amount and direction of the positioning error of each suction nozzle 210, on the basis of the suction-nozzle code identifying the suction nozzle 210 and the rotating speed of the cam 112 which are used to mount the electric component 28 on the board 38, and according to sets of estimated positioning error data ΔXC, ΔYC which are obtained and stored in the RAM 306 in relation to the suction-nozzle code identifying the respective suction nozzles 210 and the rotating speed of the cam 112 used to obtain the positioning error data. It will also be understood that the speed-control-pattern changing

means of the control-target determining portion is a portion of the control device ~~350~~ 300 assigned to change or select the rotating speed of the cam 112 between or from two values depending upon the kind of the electric component 28, and that the test-chip mounting control means of the control-target determining portion is a portion of the control device ~~350~~ 300 assigned to move each of component-holding head 140 holding the test chip 330, at each of the two different rotating speed values selected by the speed-control-pattern changing means, and operate the head 140 to mount the test chip 330 on the test substrate 332. It will further be understood that the data processing means of the control-target determining means is a portion of the control device ~~350~~ 300 assigned to obtain the estimated positioning error data ΔXC, ΔYC for each suction nozzle 210 and for each of the two different rotating speed values of the cam 112, by processing image data representative of images of the test chips 330 as mounted on the test substrate 332, which images are taken by the fiducial-mark camera 70. It will also be understood that the control-target determining means of the control-target determining portion is a portion of the control device ~~350~~ 300 assigned to store the sets of estimated positioning error data ΔXC, ΔYC obtained by the data processing means, in relation to the suction-nozzle code and each of two rotating speed values of the cam 112. It will further be understood that a portion of the RAM 306 serves as memory means for storing the sets of estimated positioning error data ΔXC, ΔYC in relation to the suction-nozzle code and each of the two rotating speed values of the cam 112. The control-target determining portion may be considered to be constituted by a portion of the control device ~~350~~ 300 assigned to read out one of the sets of estimated positioning error data ΔXC, ΔYC from the memory means, on the basis of the suction-nozzle code and the rotating speed of the cam 112 used to mount the electric component 28 on the board 38.

Please replace paragraph **[0130]** with the following rewritten paragraph:

[0130] The electric-component mounting system according to the second embodiment, which is constructed as disclosed in Japanese Patent No. 2824378, will be described in detail regarding a portion of the system which relates to the present invention. In ~~Fig. 14,~~ Fig. 15 reference numeral 410 denotes a machine base on which are mounted a plurality of columns 412 extending upright. On the machine base 410, there is also disposed a printed-wiring-board conveyor (PWB conveyor) 418 arranged to feed a printed-wiring board 416 in the X-axis direction (right and left direction as seen in Figs. 15 and 17). The printed-wiring board 416 is transferred by the PWB conveyor 418, and is stopped by a suitable stopper device (not shown) at a predetermined component-mounting position. The printed-wiring board 416 located at the component-mounting position is supported by a printed-wiring-board supporting device (not shown) such that the board 416 maintains a horizontal attitude.

Please replace paragraph **[0132]** with the following rewritten paragraph:

[0132] The component supply device 422 of tray type includes a multiplicity of component trays 425 each accommodating a multiplicity of electric components 431 (Fig. 17) in respective recesses. The component trays 425 are accommodated in respective multiple tray boxes 426 (shown in Fig. 16) which are vertically arranged and are supported by respective support members (not shown). The tray boxes 426 are elevated one after another by an elevator device disposed within the column 412 to a predetermined component-supply position. For a component-holding head 460 (which will be described) to receive the electric components 431 from the component tray 425 in the ~~ray~~ tray box 426 located at the component-supply position, some vertical space must be provided above the component-supply position.

Please replace paragraph **[0133]** with the following rewritten paragraph:

[0133] To provide the vertical space, the tray box 426 from which the electric components have been transferred to the component-holding head 460 is moved further upwards from the component-supply position to a predetermined retracted position when the next tray box ~~462~~ 426 is moved to the component-supply position, so that the required vertical space is provided between the component-supply position and the retracted position. The component supply device 422 of tray type is identical in construction with a component supply device disclosed in JP-B2-2-57719.

Please replace paragraph **[0136]** with the following rewritten paragraph:

[0136] On the X-axis slide 434, there is mounted a Y-axis slide 444, as shown in Figs. 15 and 17, such that the Y-axis slide 444 is movable on the X-axis slide 434, in the Y-axis direction perpendicular to the X-axis direction in the horizontal plane. The X-axis slide 434 has a vertically extending side surface ~~464~~ 446 on which is disposed a ballscrew 448 extending in the Y-axis direction, as shown in Fig. 17. The Y-axis slide 444 has a ballnut 450 which is held in engagement with the ballscrew 448. The ballscrew 448 is operatively connected to a Y-axis drive motor 452 (Fig. 15) through gears 454, 456. The Y-axis slide 444 is moved in the Y-axis direction while being guided by a pair of guide rails 458, when the ballscrew 448 is rotated by the Y-axis drive motor 452.

Please replace paragraph **[0140]** with the following rewritten paragraph:

[0140] The electric-component mounting system according to the present second embodiment includes a control device 500 as control means, as shown in ~~Fig. 15.~~ Fig. 18. The control device 500 is principally constituted by a computer 510 incorporating a processing unit (PU) 502, a read-only memory (ROM) 504, a random-access memory (RAM) 506 and a bus interconnecting those elements. The bus is connected to an input-output interface 512 to which are connected various actuators such as the X-axis and Y-axis drive

motors 442, 452, vertical drive device 466 and rotary drive device 468, through respective driver circuit 516. The drive motors 442, 452 and the drive motors of the drive devices 466, 468 are servomotors, the operating angles or amounts of which are detected by respective rotary encoders (not shown). To the input-output interface 512, there are also connected the fiducial-mark camera 470 and component camera 472 through respective control circuits 518. The RAM 506 stores various control programs such as component-mounting programs for mounting the electric components 431 on the printed-wiring board 416, and positioning-error obtaining programs for obtaining positioning errors of each component-mounting position, on the basis of the pattern of control of moving speed of the component-holding head 460 and the component-mounting position or spot on the board 416.

Please replace paragraph **[0142]** with the following rewritten paragraph:

[0142] To mount the electric component 431 on the printed-wiring board 416, the component-holding head 460 is moved by movements of the X-axis slide 434 and Y-axis slide 444, to the component-supply portion or position of the component supply device 420 of tape feeder type or component supply ~~deice~~ <u>device</u> 422 of tray type. At the component-supply position, the component-holding head 460 receives the electric component ~~413~~ <u>431</u> from the component supply device 420, 422. In the component supply device 420 of tape feeder type, the individual tape feeders 424 have respective component-supply portions or positions which are arranged along a straight line parallel to the X-axis direction. In the component supply device 422 of tray type, the positions of the multiple recesses provided in the selected component tray 425 are the component-supply portions or positions. To hold the electric component 431, the suction nozzle 462 is lowered for contact with the electric component 431, and is communicated with a negative-pressure source, for holding the electric component 431 by suction under a negative pressure. After the electric component 431 is held by the suction nozzle 462, the component-holding head 460 is lifted.

Please replace paragraph **[0144]** with the following rewritten paragraph:

[0144] The component-holding head ~~470~~ 460 holding the electric component 431 is moved to the appropriate component-mounting position on the board 416, along a straight line connecting the component-supply portion of the selected tape feeder 424 and the component-mounting position in question. During this movement of the component-holding head 460, the head 460 passes over the prism 480 fixedly disposed on a portion of the X-axis slide 434 between the component-supply portion of the selected tape feeder 424 and the component-mounting position on the board 416. Irrespective of the position of the component-supply portion of the selected tape feeder ~~423~~ 424 and the position at which the electric component 431 is to be mounted on the board 416, the component-holding head 460 necessarily passes over the prism 480 disposed between the component-supply portion of the selected tape feeder 424 and the component-mounting position on the board 416, during the movement of the head ~~470~~ 460 in the Y-axis direction by the Y-axis slide 444 on the X-axis slide 434. Accordingly, a light which forms a silhouette image of the electric component 431 existing in the light background provided by the back light 476 is reflected by the prism 480 and is incident upon the component camera 472. Thus, the silhouette image of the electric component 431 is taken by the component camera 472.

Please replace paragraph **[0146]** with the following rewritten paragraph:

[0146] Image data representative of the image of the electric component 431 as held by the suction nozzle 462 are compared by the control device 500, with image data representative of a nominal image of the electric component 431 held by the suction nozzle ~~461~~ 462 without a positioning error with respect to the suction nozzle 462. Thus, the control device 500 obtains horizontal positioning errors ΔXE and ΔYE and an angular positioning error $\Delta\theta$ of the electric component 431 as held by the suction nozzle 462. Further, images of the fiducial marks provided on the printed-wiring board 416 are taken by the fiducial-mark

camera 470, to obtain horizontal positioning errors ΔXP and ΔYP of the board 416 as stopped at the component-mounting position. During the movement of the component-holding head ~~160~~ 460 to the appropriate component-mounting position on the board 416, head-positioning data for moving the component-holding head 460 to mount the electric component 431 are adjusted for compensation for the thus obtained horizontal positioning errors ΔXE and ΔYE of the electric component 431 and the horizontal positioning errors ΔXP and ΔYP of the board 416, and the component-holding head 460 is rotated by the rotary drive device 468, for compensation for the angular positioning error Δθ of the electric component 431. Further, the head-positioning data are also adjusted for compensation for changes of the X-axis and Y-axis positions of the electric component 431 as a result of the rotation of the electric component 431 for compensating of the angular positioning error Δθ. Those compensations permit the electric component 431 to be mounted at the predetermined component-mounting position on the printed-wiring board 416, with the predetermined attitude. The component-holding head 460 is eventually moved to a position defined by the head-positioning data, and the head 460 is lowered to lower the suction nozzle 462 for mounting the electric component 431 on the printed-wiring board 431, with the suction nozzle 462 being communicated with a positive-pressure source, to release the electric component 431. Then, the suction nozzle 462 is communicated with the atmosphere. Thus, one cycle of operation to mount one electric component 431 on the board 416 is completed.

Please replace paragraph **[0150]** with the following rewritten paragraph:

[0150] In view of the above, test operations are performed to ~~mounting~~ mount the electric components 431 on the printed-wiring board 416, and take images of the electric components 431 as mounted on the board 416, for thereby obtaining the positioning errors of the electric components 431. For simplification of description, it is assumed that the

vibration of the electric component 431 caused by acceleration of the component-holding head 460 has been attenuated during a constant-speed movement of the head 460, and that the positioning error of the electric component 431 is caused solely by the vibration caused by deceleration and stopping of the head 460 at the component-mounting position.

Please replace paragraph **[0151]** with the following rewritten paragraph:

[0151] The test operations are performed on a predetermined number of printed-wiring boards 416 of the same kind, for instance, three boards 416. All of the electric components 431 are mounted on the first printed-wiring board 416, and the fiducial-mark camera 470 are moved by the XY robot 469 to each of the predetermined component-mounting positions, to take images of these electric components 431 as mounted on the board 416. In the test operations, the component-holding head 460 is moved to each of the component-mounting positions which are defined by respective sets of head-positioning data prepared to mount the electric components 431 at the respective component-mounting positions on the board 416. The component-mounting position of the head 460 corresponding to each component-mounting position on the board 416 is the position of the axis of rotation of the nozzle holder 464 in the XY plane. The fiducial-mark camera 470 is moved to take the image of each electric component 431 mounted on the board ~~461,~~ 416, according to the head-positioning data, and the known positional relationship between the fiducial-mark camera 470 and the axis of the nozzle holder 464.

Please replace paragraph **[0157]** with the following rewritten paragraph:

[0157] In addition, the test chips are mounted with the moving speed of the component-holding head 460 being controlled in different patterns (different acceleration and deceleration values), such that the test chips are mounted on a plurality of test substrates, with the moving speed of the head 460 being kept in the same pattern (at the same acceleration and deceleration ~~values.~~ values). The moving speed of the head 460 is controlled in the same

pattern for all of the test-chip mounting positions on the same test substrate. Thus, the test chips are mounted on a plurality of test substrates, for each of the different patterns of control of the moving speed of the component-holding head 460.

Please replace paragraph **[0161]** with the following rewritten paragraph:

[0161] In the above case, the component-holding head ~~140~~ 460 is stopped at two positions, that is, at the image-taking position and the component-mounting position. Where the distance between these two positions is relatively short, there is a possibility that the vibration of the head 460 generated upon starting of the movement from the image-taking position to the component-mounting position has not been sufficiently attenuated when the head 460 reaches the component-mounting position. In this case, the set of estimated positioning errors used to adjust the head-positioning data may be determined by taking the degree of this vibration into account. Where the direction of movement of the head 460 from the component-supply position to the image-taking position is different from the direction of movement of the head 460 from the image-taking position to the component-mounting position, or where the direction of movement of the head 460 while the image of the electric component 431 is taken is different from the direction of movement from the image-taking position to the component-mounting position, this difference in the moving direction of the head 460 may be taken into account in determining the set of estimated positioning errors as the control target.